AERIAL MOOSE SURVEY
on and around
KANUTI NATIONAL WILDLIFE REFUGE
November, 2011

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and

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DATA SUMMARY

Survey Dates:	3-8 November (Intensive survey only)
Total area covered by survey:	Kanuti National Wildlife Refuge (hereafter, Refuge) Survey Area: 2,714 mi^2 (7,029 km^2); Total Survey Area: 3,736 mi^2 (9676 km^2)
Total Number sample units	Refuge Survey Area: 508; Total Survey Area: 701
Number of sample units surveyed:	Refuge Survey Area: 119; Total Survey Area: 151
Total moose observed:	Refuge Survey Area: 316 moose (171 cows, 84 bulls, and 61 calves); Total Survey Area: 351 moose (184 cows, 101 bulls, 66 calves)
November population estimate:	Refuge Survey Area: 797 moose (90% confidence interval = 644 - 951) comprised of 388 cows, 268 bulls, and 159 calves*; Total Survey Area: 1022 moose (90% confidence interval = 828 – 1215) comprised of 464 cows, 362 bulls, 199 calves*. *Subtotals by class do not equal the total population because of accumulated error associated with each estimate.
Estimated total density:	Refuge Survey Area: 0.29 moose/mi^2 (0.11 moose/km^2); Total Survey Area: 0.27 moose/mi^2 (0.11 moose/km^2)
Estimated ratios:	Refuge survey area: 41 calves:100 cows, 10 yearling bulls:100 cows, 37 large bulls:100 cows, 69 total bulls:100 cows; Total Survey Area: 43 calves:100 cows, 10 yearling bulls:100 cows, 44 large bulls:100 cows, 78 total bulls:100 cows

INTRODUCTION

The Kanuti National Wildlife Refuge (hereafter, Refuge), the Alaska Department of Fish and Game (ADF&G) and the Bureau of Land Management cooperatively conducted a moose (*Alces alces*) population survey 3 - 8 November 2011 on and around, the Refuge. Moose surveys have been conducted on Refuge since 1989 using two different methods. The Gasaway method (Gasaway et al. 1986) was employed in 1989 and 1993 and the Geo-Spatial Population Estimator (GSPE) (Ver Hoef 2002 and 2008, Kellie and Delong 2006) was used in 1999, 2004, 2005, 2007, 2008 and 2010. GSPE surveys done since 1999 have shown that the moose density in the survey area remains low, and persists at a low-density dynamic equilibrium (Gasaway et al. 1992)

Moose are an important subsistence resource for the residents of four villages which are located near the survey area: Bettles, Evansville, Alatna, and Allakaket. Estimated average harvest of moose in these villages, as measured during household surveys from 1997 through 2002, was 37 moose per year (Brown et al. 2004). Non-local hunting pressure is light in the area, both because most of the Refuge is closed to moose hunting by non-local hunters, and because the remaining open hunting areas are difficult and expensive to access. The low moose density in the area is a further disincentive for non-rural hunters. Nonetheless, the low moose density and local resident perception that subsistence harvest is declining have led to a local resident concern about allocation of moose between local and non-local hunters. Other issues related to moose management in the area are the effect of predation on the moose population and distribution of moose to areas where they are accessible to human harvest.

The objectives of the 2011 moose survey were to: 1) continue monitoring the moose population on the Refuge for management decision purposes, 2) maintain the precision of the population estimate by surveying a larger number of sample units than just the Refuge, and 3) add additional data to the Bayesian regression analysis of the moose population estimates for the Refuge.

STUDY AREA

The survey occurred over a part of Game Management Unit 24B in north-central Alaska (Figure 1). Topography in the survey area is relatively flat, with rolling hills around the periphery of the Refuge. Vegetation types include black and white spruce (*Picea mariana* and *P. glauca*, respectively) forest, black spruce woodland, paper birch (*Betula papyrifera*) forest, mixed spruce/birch forest, tall and low shrub communities, tussock tundra dominated by tussock cottongrass (*Eriophorum vaginatum*), and riparian and wetland areas dominated by willows (*Salix* spp.) and other deciduous vegetation. The types and ages of plant communities are strongly influenced by fire history; over 70% of the Refuge has burned since 1940.

Although the survey was conducted seamlessly, the survey area was treated as two entities for analysis: the Refuge Survey Area (2,714 mi^2 [7,029 km^2]) and the Total Survey Area (3,736 mi^2 [9676 km^2]). The 2010 Refuge Survey Area boundaries and sample units were the same used since 1999, which allowed comparisons with those surveys. The Total Survey Area included both the Refuge Survey Area and additional survey units of the lower Alatna River drainage west of the Refuge.

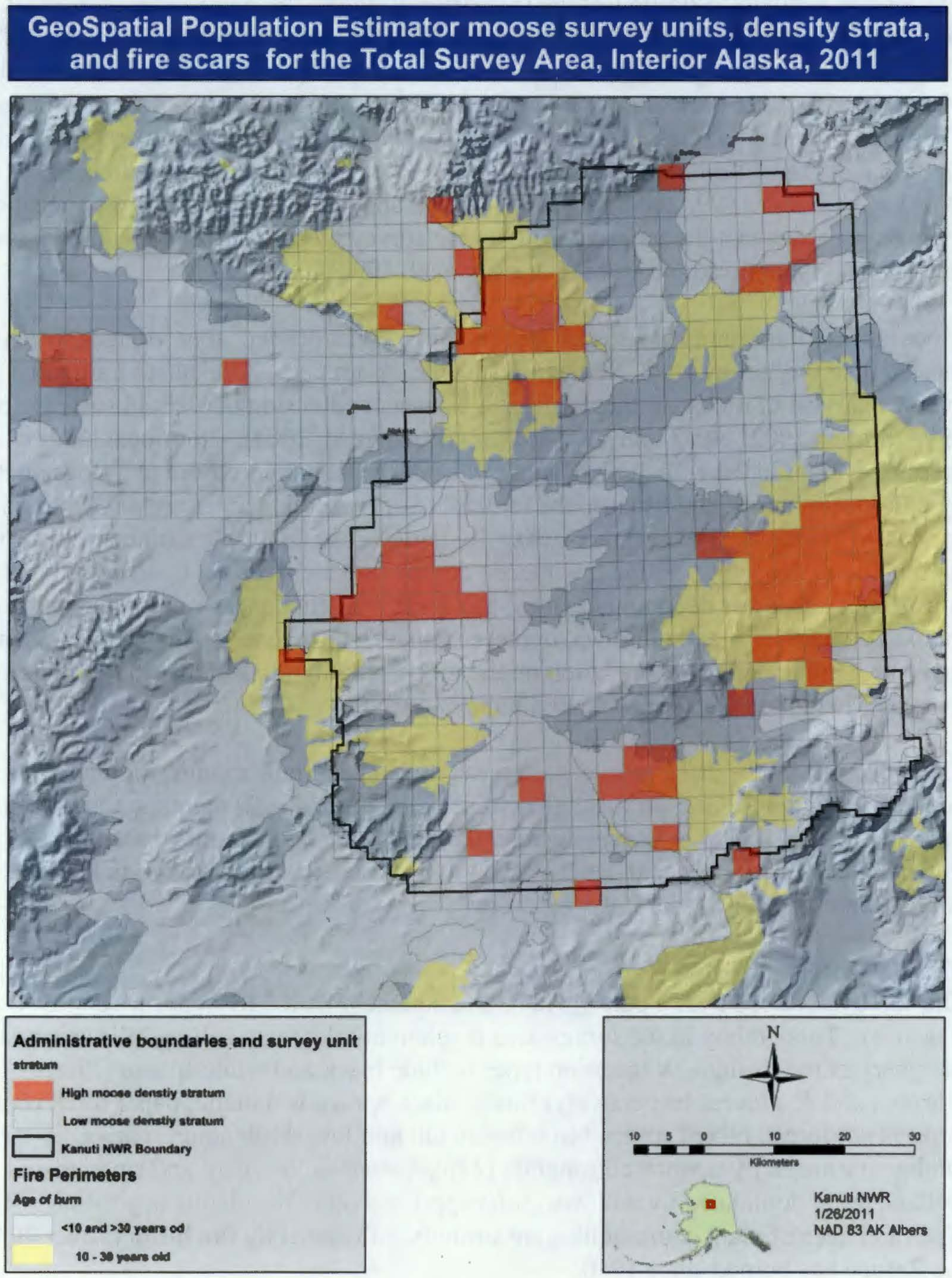


Figure 1. Survey units for a moose survey conducted in November, 2011, Game Management Unit 24B, Alaska. Kanuti National Wildlife Refuge boundary, fire perimeters for burns of two different age allocations (burns 10 – 30 years old are preferred by moose), and moose density stratum are displayed.

METHODS

The moose population survey was conducted using the GSPE method, a modification of a technique initially developed by Gasaway et al. (1986) that was used on the Refuge in 1989 and 1993. The GSPE method is widely used in Alaska which allows comparison between survey areas. Methods for the GSPE method are discussed in detail in Kellie and DeLong (2006) but will be summarized here.

The Total Survey Area was delineated using a geographical information system (GIS) layer developed by ADF&G that divides the state into a grid of sample units that measure 2 minutes latitude by 5 minutes longitude on a side. Sample units in our survey area averaged about 5.3 mi^2 (13.7 km^2) in size. The Total Survey Area included 508 sample units that were surveyed on the Refuge from 1999 to 2010. In addition, we added 193 more sample units in 2011 on State, Bureau of Land Management administered lands, and private land west of the Refuge in the lower Alatna River drainage that had not been included in past surveys. In all, the Total Survey Area consisted of 701 units.

Moose GSPE surveys have two components: stratification and intensive surveys. When funds are available, stratification flights are conducted before intensive flights to assign sample units to "High" (more than 3 moose) or "Low" (3 moose or less) moose density stratum. A good stratification survey improves the precision of population estimates by reducing the variance of the estimate. In 2011 we did not have sufficient funds to conduct stratification flights, so the 2010 stratification was used (Craig and Stout 2011).

Sample units for the survey were randomly selected from each density strata (Kellie and DeLong 2006). Approximately 10 – 20% of the units were withheld from the random selection and subjectively used to fill in between blocks of units because the GSPE has a spatial component whose results are improved if there are no gaps among surveyed units.

For the intensive survey, tandem-seated aircraft (e.g., Super Cub, Scout, and Husky) were used to survey individual units for moose. These aircraft held a backseat observer who also recorded data, and a pilot/observer who used a Global Positioning System (GPS) receiver to identify the boundaries of sample units and keep track of portions of units they had already surveyed. Search intensity varied with habitat. Greater effort was spent in areas with higher canopy cover (e.g., forests versus muskeg) or where fresh moose tracks indicated the potential presence of moose. Latitude/longitude coordinates of lone or grouped moose were recorded using the aircraft GPS receivers or hand-held GPS units operated by the back-seat observer. Each moose observed was classified as: cow, calf, yearling bull (spike or forked antlers), medium bull (a bull with antlers that were larger than spike or fork but whose antler spread was <50 inches [127 cm]), or large bull (antler spread ≥50 inches). Moose population estimates within the survey area were made using a web-based GSPE analysis program developed by ADF&G (Ver Hoef 2002, 2008; Kellie and DeLong 2006; www.winfonet.alaska.gov).

The GSPE survey methodology assumes 100% sightability of moose. However, this assumption is not often met (Boertje, ADF&G, unpublished data). Because not all of the moose in the survey areas were likely spotted during our survey, results presented herein are considered "observable" moose. In this report, an additional trend analysis was conducted on previous Refuge GSPE moose population estimates using a sightability correction factor (SCF), estimated from radio-collared moose sightability trials conducted in 2008 and 2010. For that analysis, the average of the 2008 and 2010 estimated SCF (SCF=1.16), was applied to each GSPE estimate for years when a SCF trial was not completed. Trend since 1999 was estimated with a multiplicative mixed effects model using Bayesian methods in WinBUGS (Lunn et al. 2000). A multiplicative model assesses a proportional change in slope as opposed to a linear model, which evaluates an additive change in slope. Lambda (slope) is estimated directly by the multiplicative model (Taras, ADF&G, unpublished data).

RESULTS

Survey conditions

The survey was conducted 3 - 8 November 2011. Survey conditions were generally classified as "excellent" (52%) to "good" (45%) except for a few units where "fair" (3%) conditions occurred; the latter classifications were due to light snowfall obscuring visibility in parts of the study area. Snow conditions during the survey period were good with complete snow cover of ground vegetation and frost occurring on most trees and shrubs. Temperatures hovered around 0°F (± 18°C) during most of the survey. Light conditions ranged from flat to bright light, and low to high intensity. All intensive survey pilots were experienced in survey techniques, as were all observers except one who was paired with an experienced pilot.

Stratification Results

Survey area	***# High moose density SUs (% of area)***	***# Low moose density SUs (% of area)***	***#High moose habitat SUs (% of area)***	***# Low moose habitat SUs (% of area)***	***Mean # moose observed/ High density SUs***	***Mean # moose observed/ Low density SUs***
Total Survey Area	*75 (11)*	*626 (89)*	*375 (54)*	*326 (46)*	*3.5 (SE=0.42)*	*1.2 (SE=0.21)*

Table 1. Moose survey unit (SU) classification by density and habitat quality determined in 2010, and number of moose observed in each during a survey in November, 2011 in the Total Survey Area, Game Management Unit 24B, Alaska.

Of the moose we observed during intensive surveys, 74% (260) and 80% (253) were located in the units designated as High density SUs in the Total Survey Area, and the Refuge Survey Area, respectively. Further, the mean number of moose observed in High density SUs during the surveys was almost 3 times the number of moose detected in Low

Density strata (Table 1.). These data indicate that using the 2010 stratification classifications was appropriate to use in 2011, as well.

Population survey results
Of the 508 sample units within the Refuge Surveyed Area, 119 (23%) were surveyed for moose. A total of 67 High density units (56%) and 52 Low density units (44%) were intensively surveyed. Of the 701 sample units within the Total Survey Area (Figure 2.), 151 (22%) were surveyed for moose. A total of 75 High density units (50%)

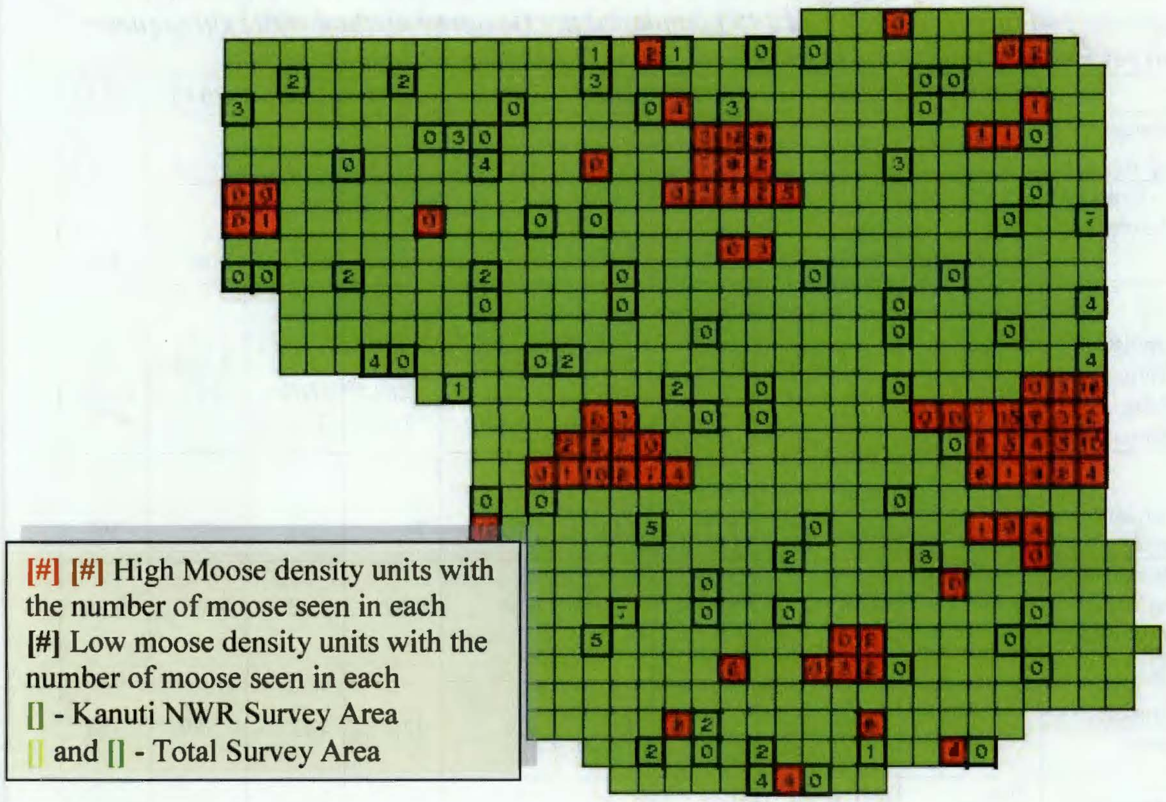


Figure 2. Moose counted in survey units in November, 2011 relative to moose density stratum. Kanuti NWR, and Total Survey Area, Game Management Unit 24B, Alaska.

and 76 Low density units (50%) were surveyed in this area. Survey time per unit ranged from 16 – 38 minutes with a mean of 24.5 ($\pm$2.0 SE) min. spent in survey units. The number of survey planes used ranged from 1 – 4 airplanes per day. The maximum number of units surveyed by any one plane during a single day was 15 (mean = 10; R = 7 – 15. Variation in the number of units surveyed depended on their distance from Bettles, light conditions, fuel needs, number of moose in a unit, local weather, and habitat cover type (e.g. units with closed tree canopy required more time to survey).

Observers classified 316 observable moose within the 119 units surveyed in the Refuge Survey Area and counted a range of 0 – 16 moose in single units. This yielded an average count of about 2.7 moose per surveyed unit. Of these moose, there were 171 cows, 84 bulls, and 61 calves. In the Total Survey Area, which included the Refuge

Survey Area, 351 moose were classified, including 184 cows, 101 bulls, 66 calves. Seven sets of twins were counted in the Total Survey Area and all were located in units that were in the Refuge Survey Area.

The GSPE population estimate for the Refuge Survey Area was 797 moose (± 153.5; 90% CI), resulting in a density of 0.29 moose/mi^2 (0.11 moose/km^2) (Table 2).

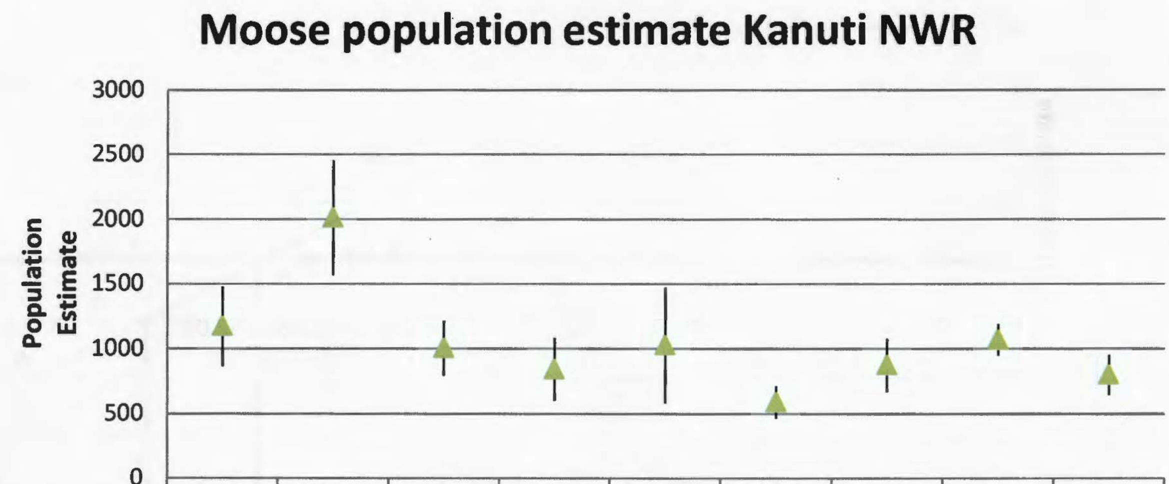
Table 2. Summary Statistics for 9 moose population estimates (90% Confidence Interval), in the Kanuti NWR Survey Area, Game Management Unit 24B, Alaska. Surveys conducted in 1989 and 1993 employed the Gasaway method while subsequent surveys were conducted using the GeoSpatial Population Estimator method.

	1989	*1993*	*1999*	*2004*	*2005*	*2007*	*2008*	*2010*	*2011*
Survey Area (sq. miles)[1]	2,615	2,644	2,715	2,710	2,710	2,714	2,715	2,714	2,714
Units Surveyed	Not applicable[2]	Not applicable[2]	108	103	82	150	80	164	151
Population Estimate (Range of Estimate)	1,172 (867 - 1,476)	2,010 (1,567 - 2,453)	1,003 (794 – 1,211)	842 (602 – 1,083)	1,025 (581 – 1,470)	588 (463- 714)	872 (669 – 1,075)	1,068 (946- 1,191)	797 (644- 951)
Standard Error	Not available	Not available	127	146	270	76	124	74.5	93
Moose Density (moose/sq. mi)	0.45	0.76	0.37	0.31	0.38	0.22	0.32	0.39	0.29
Estimated Cows	Not Available	Not Available	542	403	471	276	432	569	388
Estimated Bulls	Not Available	Not Available	320	252	331	167	199	293	268
Bulls:100 Cows	64	61	59	62	70	60	46	51	69
Yearling Bulls:100 Cows	4	8	4	9	20	13	14	7	10
Calves:100 Cows	17	33	30	46	43	53	58	33	41

[1] Survey areas vary among years depending on how survey units were delineated

[2] Survey units varied in shape and size and are not comparable to units used in subsequent surveys

The relatively narrow 90% confidence interval (it is standard practice to compare 90% CI among GSPE surveys in Alaska) for the 2011 population estimate confirms that this is one of the more precise estimates of the moose population on the Refuge Survey Area to date (Figure 3). We plotted the 90% confidence error of the estimated total number of observable moose against the corresponding number of sample units for all GSPE surveys completed on the Kanuti NWR. We determined that a sampling intensity of 125-145 sample units is needed to achieve a 90% CI of 15-20% of the total estimate (Figure 4).



	1989	1993	1999	2004	2005	2007	2008	2010	2011
Upper CI	1476	2453	1211	1083	1470	714	1075	1191	951
Lower CI	867	1567	794	602	581	463	669	946	644
▲ Estimate	1172	2010	1003	842	1025	588	872	1068	797

Figure 3. Observable moose population estimates on Kanuti NWR, Game Management Unit 24B, Alaska. Error bars represent the 90% confidence interval for each year.

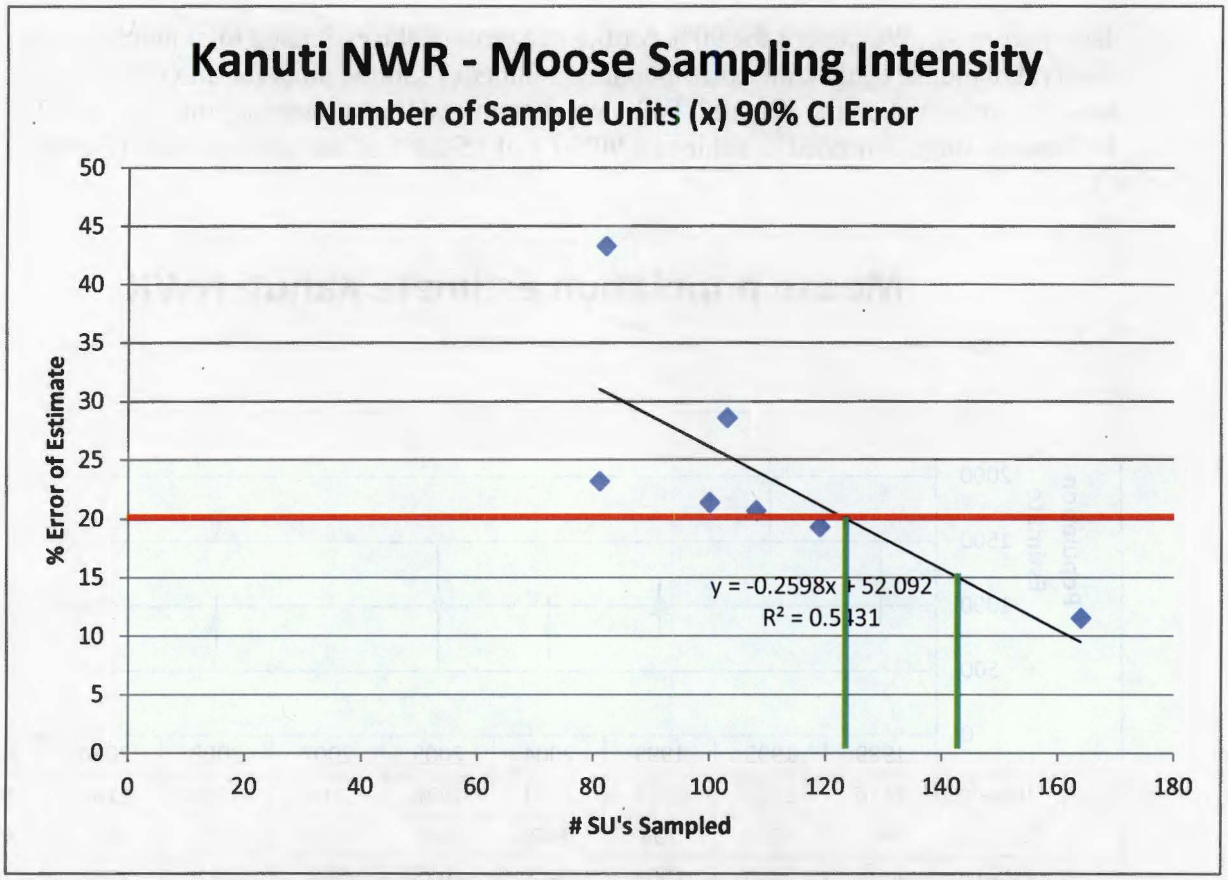


Figure 4. Number of sample units surveyed and the percent error of the estimated total number of moose from seven GSPE moose surveys conducted from 1999 to 2011, on Kanuti NWR, Game Management Unit 24B, Alaska. The red line represents a potential threshold sampling objective, the green lines represent a range of the number of sample units needed to achieve the sampling objective threshold of 15-20% sampling error, and the black line is a linear regression of the seven data points.

Estimated moose densities by sex and age class in the Refuge Survey area were 0.10 bulls/mi^2, 0.14 cows/mi^2, and 0.06 calves/mi^2 (0.04/km^2, 0.06/km^2, and 0.02/km^2, respectively). Population estimates and ratios (indexed to 100 cows) for bulls by age class for the Total Survey Area are presented in Table 3.

Table 3. Estimated bull moose population and age ratios in November, 2011 indexed to 100 cows in the Kanuti NWR and Total Survey Area, Game Management Unit 24B, Alaska.

	All bulls	Yearling bulls[b]	Large bulls
Population estimate			
Kanuti NWR Survey Area	268	37	145
Total Survey Area	362	45	206
Ratio estimate: 100 cows			
Kanuti NWR Survey Area	69:100	10:100	37:100
Total Survey Area	78:100	10:100	44:100
90%CI[a]			
Kanuti NWR Survey Area	188 - 349	21 - 53	81 - 209
Total Survey Area	251 - 473	25 - 66	121 - 291

[a] Upper and lower estimate of confidence intervals (CI).
[b] Assuming a 50:50 sex ratio for yearlings, total yearling density in the survey area is expected to be twice that of yearling bulls

Costs by agency for the 2011 GSPE survey are found in Appendix 1. Complete survey results for the entire 2011 survey are archived in, and can be retrieved from, the Alaska Department of Fish and Game's WINFONET database (http://winfonet.alaska.gov/; accessed 25 January 2011). An example of output from WINFONET is found in Appendix 2.

The trend analysis conducted for GSPE estimates since 1999 shows the SCF moose population estimate was stable at approximately 1,000 moose (Lambda = 0.9996 [SE=0.024]; Lambda was not significantly different than 1.0 at the 90% confidence level) (Figure 5, Appendix 3). Small annual fluctuations may be explained by annual variance in the survey sampling or small fluctuations in moose abundance. Regardless, the population trend is consistent with a low-density dynamic equilibrium moose population described by Gasaway et al. (1992).

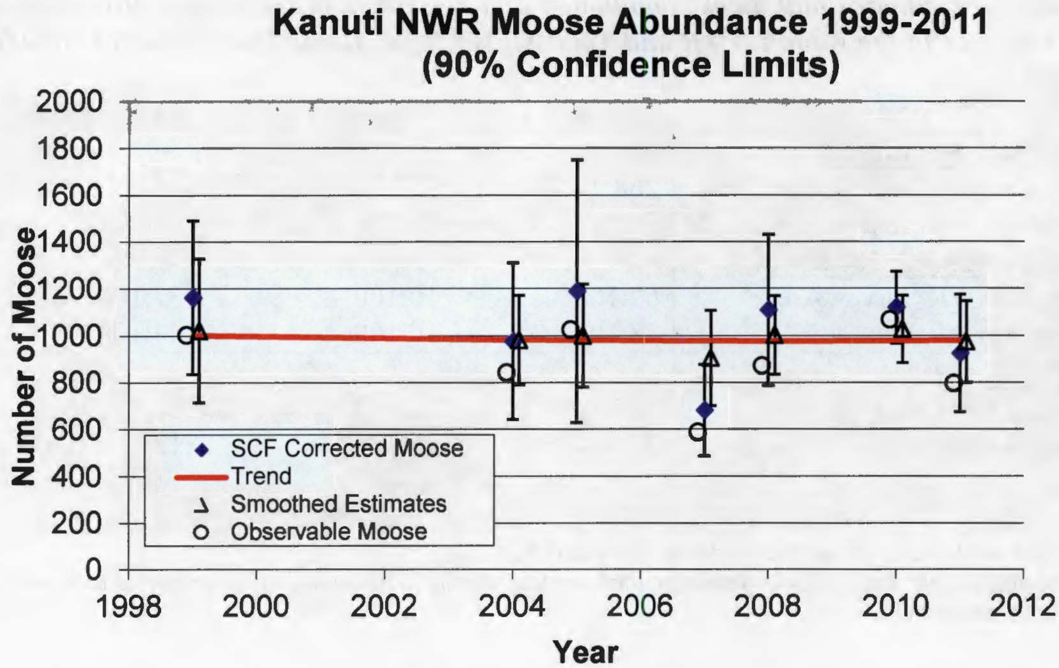


Figure 5. Sightability corrected moose population estimates on the Kanuti NWR, Game Management Unit 24B, Alaska. Error bars represent the 90% confidence interval for each year.

DISCUSSION

The Refuge Survey Area has been surveyed seven times using GSPE techniques since 1999. Even though we used stratification data from 2010, the data collected in 2011 resulted in the third most precise (tight CIs) of these moose surveys. This probably resulted for three reasons. First, the precision of a population estimate of a subset of SUs is improved in the geospatial analysis by surveying a contiguous, larger area. Therefore, surveying units in the Total Survey Area improved the precision of the estimates in the smaller Refuge Survey Area. Secondly, all of the pilots and all but one of the observers had experience surveying moose with the GSPE method. Lastly, we had very good survey conditions with adequate snow cover and light conditions. Determining a Sightability Correction Factor (SCF) for moose during a survey greatly improves actual moose population estimates. We did not have adequate funds to conduct a SCF trial for the 2011 survey. The sampling intensity analysis shows that a minimum of 125 sample units should be surveyed intensively to achieve a high quality survey (high quality = less than 20% error on Confidence Interval) for a single-year "point estimate" of the moose population. However, the Bayesian smoothing analysis of Sightability Corrected estimates improved the average 90% CI from ±29.6% to ±20.3% for the seven Kanuti surveys. It is expected that additional survey data will further reduce the confidence intervals of earlier estimates. Therefore, although the strategy for conducting a single high quality survey would dictate a sampling intensity of 125 sample units, our alternative "low-intensity" sampling strategy of 80-100 sample units provided the desired results for our management purposes and nearly achieved the same desired precision threshold of 20%. Furthermore, low-intensity surveys conducted on a regular basis, with periodic high-intensity surveys, also produced estimates that allowed a precise analysis of trend (Fig. 5). Low-intensity surveys are affordable and are more likely to be conducted frequently, which enables managers to monitor population trend. Further assessment of this sampling strategy will be evaluated using future survey data, to determine the sampling intensity and frequency required to detect small population changes (5-10%) for this low density population.

Moose population density estimates determined for the Refuge Survey Area over the years have ranged from 0.22 to 0.39 moose/mi^2. However, the confidence intervals for all of these population estimates overlap. These data indicate that while moose numbers probably do fluctuate somewhat in the survey area, the moose density has remained consistently low over the past decade. This is typical for Interior Alaska moose populations where hunting and trapping pressure on predators is low. Gasaway et al. (1992) report a mean density of 0.38 moose/mi^2 (0.15 moose/km^2) for 20 moose populations in Alaska and the Yukon Territory where predation was thought to be a limiting factor. Where predation was not thought to be limiting, the mean density of 16 populations was 1.7 moose/mi^2 (0.66 moose/km^2). The current estimated moose density or observable moose on KNWR Survey Area is 0.29 moose/mi^2 while the average over the years when GSPE methods were used is 0.33 moose/mi^2 ($\pm$0.06).

The Refuge Survey Area moose population has maintained a relatively high bull/cow ratio (46 – 70 bulls/100 cows). This is probably a result of the low human harvest on the Refuge due to past management strategies. A minimum of 20 bulls:100 cows in the fall is considered adequate to maintain moose numbers, except in low density areas like the Refuge, where moose are more widely dispersed. In this low density population, a ratio of 30 – 40 bulls:100 cows (ADF&G 2001) may be required to maintain the population.

Browse condition is often used as a measure of moose habitat quality (Franzmann and Schwartz 1998, Paragi et al. 2008). Stout (2008) reported that there were very low levels of browse removal in GMU 24B during a study in late winter in 2007. Similarly, twinning rates are a good index of the nutritional status of moose, (Boertje et al. 2007, Franzmann and Schwartz 1985, Paragi et al. 2008). Twinning rates of radio-collared cows were high (37 – 60%) in portions of GMUs 24 A&B in 2009 to 2011, including the Refuge Survey Area (T. Hollis, unpublished ADF&G memoranda 2011). Saperstein (2009) reported that almost half of the Refuge survey area was classified as high quality habitat for moose during the 2007 GSPE survey and we found similar results during our habitat stratification of the Total Survey Area in 2010 (only 46% of the area was considered low quality habitat). In contrast to the habitat stratification, we found that units with High moose density only occurred in 11% of the Total Survey Areas in 2010. The browse removal and twinning data, coupled with these habitat and density stratification results, suggest that while moose occur at low density in the survey area, habitat does not appear to be a factor limiting the population. Winters are marked by severe cold weather in our study area, but winters with snow deep enough to (>36 in) likely influence moose habitat selection or cause high energy expenditures (Coady 1974) occurred in only 4 of the last 14 years (1997-2010). Blood assessment of moose radio-collared in 2007 in GMUs 24 A&B showed low incidence of exposure to common diseases.

Calf ratios of 20 - 30 calves:100 cows are suggested necessary to maintain a stable moose population; ratios exceeding that are needed for moose populations to grow (ADF&G 2001). In the 2011 GSPE survey, we estimate there were 41 calves/100 cows on the Refuge. Similarly, the estimated calf:cow ratios in 5 of the 7 GSPE surveys conducted in the past have exceeded 40 calves/100 cows. These fall calf:cow ratios indicate the moose population on the Refuge Survey Area has adequate productivity to grow. However, we have detected no commensurate increase in moose density in the study area in the past decade.

We have not studied the fate of moose calves between birth and November or of yearlings on the Refuge Survey Area. However, it is clear that recruitment is below potential for this population when considering the high twinning rates we have observed, and the relatively low number of calves and yearling bulls in November surveys. Within the Koyukuk River drainage, downstream from the Refuge, Osborne et al. (1991) found that black bears (*Ursus americanus*) were responsible for 40% of the calf (< 6 mo. old) mortalities, while brown bears (*Ursus arctos*) (3%) and wolves (*Canis lupus*) (9%) accounted for far fewer mortalities. Bertram and Vivion (2002) found that even though moose on the nearby Yukon Flats National Wildlife Refuge had high pregnancy and twinning rates, predation by black bears (45%), and grizzly bears (39%) were responsible for low (28%) neonate survival. Others report that predation by bears and wolves can limit growth in low-density moose populations that are lightly hunted in Alaska and the Yukon (Gasaway et al. 1992). It is probable that the mortality of subadult moose, particularly evident in the low yearling bull ratios that we have observed in our surveys, is also due to predation by bears and wolves.

Moose habitat quality in Interior Alaska is often related to ecological succession in areas that have burned and subsequently change through time. The Refuge Survey Area is largely a fire-dominated ecosystem and has experienced several large fires since 1990. Research elsewhere in Interior Alaska indicated that burns between 10 – 30 years old are preferred over younger burns by moose (Maier et al. 2005). This was supported by observations on the Refuge in past moose surveys, and during the 2011 survey, as well. Many of the High moose density units in both the Total Survey Area and the Refuge Survey Area were in burns that were more than 10, but fewer than 30 years old. One exception is a hilly, older burn about 20 km south of Allakaket where the terrain, with its varied microsites, apparently still hosts habitat attractive to moose. Climate change models predict an increased incidence of fire in Interior Alaska (Rupp 2009) concurrent with a drying trend (SNAP 2009). It is difficult to predict how these changes will affect moose habitat in the survey area in the future.

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APPENDIX 1

Cost by Agency

Kanuti National Wildlife Refuge moose survey costs, November 2011

Vendor	Description	Flight hours	Cost
OAS (Spindler)	Scout	32	$4,000
Bettles Lodge	Fuel		$ 690
Wright's	Travel/Freight		$ 721
Fred Meyers	Food		$ 213
Total			$5,624

Bureau of Land Management moose survey cost, November 2011.

Vendor	Description	Costs
Bettles Lodge	Fuel	$3,000.00
Total		$3,000.00

Alaska Department of Fish and Game moose survey costs, November 2011

Vendor	Description	Costs
Fred Meyers	Food	$ 588
Wrights	Travel/freight	608
Bettles Lodge	Fuel	3,232
Tundra Air (Marty Webb)	Air charter	3,636
Papa Zulu Air (Paul Zaczkowski)	Air charter	6,532
Husky Air (Dan Sailors)	Air charter	5,616
Total		$ 20,212

Appendix 2

Survey and Inventory Tools

Home

Change Password
Logout

WinfoNet

Moose Surveys - Population/Ratio Estimates

Main Menu | AppBuilt | Retrieve | Estimates | Documents | Data Security

Home -> Survey and Inventory Tools -> Moose Surveys -> Moose Surveys - Population/Ratio Estimates

Do A Ratio Estimate | Do Another Population Estimate

Moose Population Estimate--Geo Technique

Survey: 24B KANUTI
Year: 2011
Season: Fall

REQUEST PARAMETERS	
Analysis Column	[TotalMoose]
Analysis Area	KANUTI
Strata Column	StratName
Counted Column	Counted
Unit Area Column	AreaMi

Right click to download data used to calculate estimate.
Right click to download RCode used to calculate estimate.

RESULTS

Estimate		Confidence Intervals		
		Confidence	Interval (moose)	Interval (proportion of the mean)
Population Estimate	797.2898	80%	677.5869 916.9923	0.1501370
Standard Error	93.4045	90%	643.6528 950.9263	0.1926988
		95%	614.2201 980.3590	0.2296148

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		95%	614.2201 980.3590	0.2296148

SAMPLE DETAILS

Total Samples	Stratum N 1 HIGH 75 2 LOW 626 3 TOTAL 701	Total Area	Stratum Area 1 HIGH 389.967 2 LOW 3350.676 3 TOTAL 3735.683
Sample Sizes	Stratum n 1 HIGH 75 2 LOW 76 3 TOTAL 151	Area Sampled	Stratum Area 1 HIGH 390.357 2 LOW 406.035 3 TOTAL 806.331
Moose Counted	Stratum Counted 1 HIGH 260 2 LOW 91 3 TOTAL 351		

ESTIMATE DETAILS

Stratum	HIGH	LOW
Empirical Semi-Variogram	distance gamma np 1 4.806247 0.4621887 290 2 9.488468 0.6100215 460 3 15.687677 0.5483833 268 4 21.488596 0.4497327 164 5 28.263036 0.3810001 122 6 35.008804 0.3871168 370 7 40.842368 0.4837411 526 8 46.884232 0.4431914 604	distance gamma np 1 4.261816 0.08475493 80 2 9.889170 0.11764838 164 3 16.292504 0.12773460 278 4 21.868866 0.12459021 326 5 28.181482 0.12840302 424 6 34.419907 0.12615179 458 7 40.868386 0.11923677 462 8 46.989909 0.09849628 486
Parameter Estimates	nugget psill range 1 0.3593572 0.1328455 7.471482	nugget psill range 1 0.01331061 0.1181260 4.486124

Appendix 3

Kanuti Moose Abundance 1989-2011

ABUNDANCE ESTIMATES

Year	*Estimated Observable Moose Abundance*	*Abundance Standard Error*	*SCF*[1]	*SCF Standard Error*	*Estimated SCF Moose Abundance*	*Abundance Standard Error*
1989[2]	1171	170.04	1.0012	0.024	1172	172.55
1993[3]	1759	189.52	1.143	NA	2010	261.68
1999	1003	126.73	1.160	0.135	1163	198.96
2004	842	146.05	1.160	0.135	997	202.94
2005	1025	270.24	1.160	0.135	1189	340.57
2007	588	76.37	1.160	0.135	682	118.41
2008	872	123.60	1.272	0.135	1109	195.54
2010	1068	74.45	1.048	0.046	1120	92.18
2011	797	93.40	1.160	0.135	925	152.06

[1]1989 and 1993 SCFs estimated using Gasaway et al. (1986) method of increased search intensity. 2008 and 2010 SCFs estimated using radio-collared moose (ADF&G memorandum "GSPE Sightability Trials 2008-2010"). SCFs for the remaining years were an average of 2008 and 2010 with standard error equal to the maximum of 2008 and 2010.
[2]Estimates from MoosePop (http://winfonet.alaska.gov/).
[3]Estimates from Martin, P. A. and A. H.Zirkle. 1996. Moose Population Estimate, Kanuti National Wildlife Refuge November, 1993. U.S. FWS final report.
All other estimates from Table 2.